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CHOATE, HALL & STEWART

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EXCHANGE PLACE

53 STATE STREET

BOSTON, MASSACHUSETTS 02109-2891

TELEPHONE (617) 248-5000

FACSIMILE (617) 248-4000

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Washington, DC 20231

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**TRANSMITTAL LETTER FOR SMALL ENTITY APPLICATION**

Dear Sir:

Please find enclosed a patent application and formal papers as follows:

Applicant(s): Johnson, et al.

Title: APPLICATION OF WATER NANOCLOUDS TO SKIN

No. Pages Specification: 17; No. Pages Claim 4 No. Pages Drawings 10;  
No. Pages Abstract 1:

Basic Filing Fee (Small Entity): \$345.00

Additional Fees:

Total Number of Claims in excess of 20 times \$9: (4 X \$9) \$36.00

Number of Independent Claims minus 3 times \$39: (0 X \$39) \$0.00

Multiple Dependent Claims (\$130)(\$260): \$0.00

Total Filing Fee: \$381.00

Also enclosed is:

- Executed Statement Claiming Small Entity Status
- Executed Right of Assignee Form
- Executed Declaration
- Executed Appointment of Attorney
- Copy of Executed Assignment
- Information Disclosure Statement
- Check in the amount of **\$381.00**

If this application is found otherwise to be INCOMPLETE, or if at any time it appears that a TELEPHONE CONFERENCE with counsel would helpfully advance prosecution, please telephone the undersigned at any time.

Please charge any additional fees or credit any overpayments which may be required to our Deposit Account No. 03-1721.

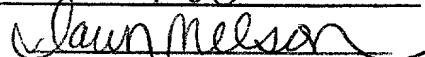
Kindly acknowledge receipt of the foregoing application by returning the self-addressed postcard.

Respectfully submitted,



Brenda Herschbach Jarrell, Ph.D.  
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Express Mail #EE441114618US  
Joint

APPLICATION  
FOR  
UNITED STATES LETTER PATENT

TO THE COMMISSIONER FOR PATENTS:

BE IT KNOWN, that I, **Keith Johnson of Cambridge, Massachusetts**; have invented certain new and useful improvements in the **APPLICATION OF WATER NANOCLUSTERS TO SKIN** of which the following is a specification:

Patent Pending

# APPLICATION OF WATER NANOCLOUDS TO SKIN

## BACKGROUND OF THE INVENTION

- 5        Much of the cosmetic industry has been and continues to be focused on the development of effective skin moisturizers to help overcome the skin hydration barrier. However, the typical cosmetic moisturizing formulation uses oil formulations to deliver various active ingredients, with water present as a non-active ingredient carrier, which typically evaporates from the skin surface
- 10       The pharmaceutical industry has likewise devoted a significant part of its resources toward the development of drugs that can be delivered transdermally for the treatment of afflictions ranging from skin disorders to bodily disease. Transdermal drug delivery systems provide for the controlled release of drugs directly into the bloodstream through intact skin. Transdermal drug delivery is an attractive alternative that can be used often when oral drug treatment is not possible or desirable. In particular, with transdermal administration long duration of action and controlled activity is achieved.
- 15       Industry is continually seeking to develop more effective applications of beneficial formulations to the skin.

## BRIEF SUMMARY OF THE INVENTION

- 25       The present invention provides water nanocluster/oil (W/O) formulations and methods for delivering water nanoclusters to the skin. In one aspect, the invention provides a process for the delivery of water nanoclusters through the outermost layer of human skin by preparing a water nanocluster composition comprising water nanoclusters having a least one dimension between about 0.5 and 10.0 nanometers (about 5- 100 Angstroms) and an oil formulation as a W/O emulsion, and applying said water nanocluster composition onto the outermost layer of human skin.

The present invention also provides a water nanocluster/oil W/O emulsion composition comprised of (1) about 5 to 50% by weight water containing water nanoclusters having at least one dimension between about 0.5 and 10.0 nanometers (about 5-100 Angstroms), and preferably less than about 1.0 nanometer, (2) about 5 to 50% by weight of one or more surfactants selected from the group consisting of fatty acids, ethoxylates and alcohols, and (3) about 10 to 90% by weight being oils, including other beneficial ingredients.

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## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts a pentagonal 5-molecule water nanocluster

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FIG. 2 depicts a 20-molecule pentagonal dodecahedral water nanocluster

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FIG. 3 depicts a 20-molecule pentagonal dodecahedral water nanocluster interacting with a typical fatty acid surfactant, oleic acid. The red spheres represent oxygen atoms, the blue spheres represent carbon atoms, and the white spheres represent hydrogen atoms.

25

FIG. 4 depicts the ability of the cage structure of the water nanocluster to engulf and clathrate the hydrophobic lipid molecule to counteract the hydrophobic effects of the lipid hydrophobes.

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FIG. 5 depicts the ability of the outermost electronic structure of the water nanocluster to give up an electron and function as an antioxidant.

FIG. 6 depicts the ability of the outermost electronic structure of Vitamin E to give up an electron and function as an antioxidant.

15 FIG. 7 depicts a needle-like array of five pentagonal dodecahedral water clusters sharing a pentagonal face between neighboring dodecahedra.

5 FIG. 8 depicts an “end-on” view of the needle-like array of water clusters shown in the above Fig. 7. Note the cavity that runs down the length of the needle.

10 FIG. 9 depicts the ability of the outermost electronic structure of the needle-like array of water clusters shown in FIG. 7 to give up an electron and function as antioxidant. (Cf. FIG. 5).

15 FIG. 10 depicts the stabilization of the needle-like array of water clusters shown in FIGS. 7 by a single fatty-acid surfactant such as oleic acid.

## 15 DETAILED DESCRIPTION OF THE INVENTION

20 Water clusters of the type used in the present invention are described in United States Patents Nos. 5,800,576 and 5,997,590, both of which are incorporated herein by reference. The specific formulations described therein are waterclusters/fuel emulsions, but the teaching of the form of the water cluster components (e.g., see columns 1-14 and Figures 1-10 of USP 5,997,590) are the same as those water clusters useful in this invention. The water clusters are preferably concatenated pentagonal water clusters like that shown in Fig. 12 of USP 5,800,576 and are comprised of twenty-one or fewer water molecules and 25 having at least one dimension of 8A (0.8nm) or less. For example, individual water clusters in dodecahedral form are essentially spherical in shape and have a diameter of about 0.8 nanometer (see Figure 2); those in pentagonal form are puckered rings and have a diameter of about 0.5 nanometer (see Figure 1).

30 The water clusters can be present as individual water cluster units and/or as an array of aggregated water cluster units. The pentagonal water cluster

shown Figure 2 and the dodecahedral water cluster shown in Figure 1 are examples of individual water clusters. Figure 7 shows an array of five dodecahedral water clusters in a needle-like array. One dimension of the array of water clusters is less than about one nanometer (10 Angstroms), with the length 5 of the array being about 3 nanometers (about 30 Angstroms) (see Figure 7).

The type and size of the individual water clusters, as well as the degree and type of aggregation thereof, will and may vary in a given water cluster formulation of this invention. For example, a given composition of this invention 10 may contain individual pentagonal and pentagonal dodecahedral water clusters, some of which may be in the form of multi-cluster arrays, e.g., needle-like arrays like that shown in Figure 7. Regardless of the water cluster type, size and degree of aggregation, one dimension of the water cluster or array thereof, about 10.0 nanometers (100 Angstroms), preferably less than about one nanometer (10 15 Angstroms), most preferably less than or equal to about 0.8 nanometer (8 Angstroms).

All of the water which is present need not be in the form of water clusters. Some of the water may be present in traditional bulk water form (i.e., in the form 20 of globules larger than 10 nanometers or 100 Angstroms in diameter, which exhibit all the physical characteristics of bulk water). Since the benefits of the present invention are attributed to the presence of the water clusters, it is preferred that a substantial (most preferably greater than 50 %) portion of the water present be in the water cluster form.

25 The water nanoclusters of the present invention can be produced by a variety of means as taught in the aforesaid referenced patents (e.g., see columns 9-10 of USP 5,997,590). However, for purposes of this invention, use of 30 surfactants to produce the desired nanoemulsion (as described below) is most preferred.

The oil formulations useful herein include for cosmetic applications: cosmetic industry oils such as soybean, peanut, olive, sesame and paraffin. Suitable cosmetic oil formulation may also include any of a variety of additives useful or non-deleterious in a cosmetic product, such as oil soluble vitamins and 5 other cosmetic nutrients (e.g., Vitamin E), fragrances and other active (e.g., sunscreens) or inert additives, which are preferably soluble in the oil.

The preferred oil formulation for pharmaceutical applications is light mineral oil. This oil is used to produce pharmaceutical formulations useful 10 herein, which include pharmaceutical ingredients, such as FDA-approved dermatological drugs and vitamin supplements of all types, which are soluble at to a reasonable degree in the oil and/or water nanoclusters. Preferred examples of pharmaceutical ingredients that made be included in the inventive compositions and processes include the topical delivery of Vitamins C and E, 15 which may be for example used to prevent or reverse skin damage due to sun exposure or aging. Vitamin C, soluble (clathrated) in the water nanoclusters, stimulates the production of collagen in the skin and functions as an antioxidant along with the antioxidant property of the water nanoclusters. Vitamin E, soluble in the oil, functions along with the water nanoclusters as antioxidant scavenger of 20 cell-damaging free radicals, and the present invention provides for effective delivery thereof to the skin. Additional or alternative preferred pharmaceutical ingredients include FDA-approved transdermally deliverable "classic" drugs such as hormonally active testosterone, progesterone, and estradiol, glycyrrhizinate (e.g., for treatment of angina), hyoscine (e.g., for seasickness), nicotine (e.g., for 25 smoking cessation); prostaglandin E1 (e.g., for treatment of erectile dysfunction); proteins and peptides; DNA and oligonucleotides (e.g., for gene therapy; DNA vaccines).

The types of suitable surfactants include fatty acids, ethoxylates and long 30 chain alcohols. Short chain alcohols are also used as cosurfactants. A preferred surfactant has a polar end (typically a carboxyl COOH group) which attaches

itself to a water cluster. Preferably, the surfactant also has at least one long (preferably 6-20 carbons) linear or branched hydrophobic "tail" that is soluble in the cosmetic oil. The surfactants are preferably present in the up to 50% by weight range.

5

Preferred fatty acids include hydrolysis products of edible oils, e.g., soybean or Canola oil. These materials consist mainly of oleic and linoleic acid. Purified cuts of these containing larger amounts of these acids can also be used. Fatty acids are examples of anionic surfactants. Anionic surfactants are known to penetrate and interact strongly with skin (P. Morganti et al., *J. Appl. Cosmetol.* 8, 23, 1990; 12, 25-30, 1994). Most anionic surfactants can induce swelling of the stratum corneum and the viable epidermis (P. Morganti et al., *Int. J. Cosmet. Sci.* 5, 7, 1983; M. Chvapil and Z. Eckmayer, *Int. J. Cosmet. Sci.* 7, 41-49, 1985). It has been suggested that in conventional cosmetics, the hydrophobic interaction of the alkyl chains with the substrate leaves the negative end group of the surfactant exposed, creating additional anionic sites of the skin membrane (P. Morganti et al., *Int. J. Cosmet. Sci.* 5, 7, 1983). However, our preferred water clusters in cosmetic formulations bind the negative end group of the surfactant, reducing or eliminating any skin-irritating effects while actually increasing the hydration level of the tissue.

20

Some cationic surfactants in skin formulations are more irritating to the skin than the anionics and generally would be less suitable for stabilizing water-cluster nanoemulsions.

25

Nonionic surfactants have the smallest potential for producing skin irritation. In conventional cosmetic microemulsions, they seem to have the ability to partition into the intercellular lipid phases of the stratum corneum, leading to increased "fluidity" in this region. Water-cluster cosmetic nanoemulsions stabilized by nonionic surfactants or a mixture of nonionics and anionics are the preferred compositions.

Ionic surfactants generally have an advantage over nonionic surfactants in being more effective in stabilizing a given amount of water. In addition, they are far more resistant to emulsion breaking at elevated temperature than nonionics.

Nonionics maintain themselves at the interface because the polar groups (e. g., -OH) hydrogen bond with water. However, the hydrogen bond is a weak bond (e.g., about 5 Kcal/mol) and becomes less effective as temperature rises above ambient.

Fatty acids are effective detergents but only when at least partially neutralized. Frequently ammonia or organic bases are used to neutralize fatty acids. Ammonia can be an effective neutralizing agent, but is a very weak base and will serve to neutralize only a fraction of the carboxylate, which is also a weak acid.

Amines are effective organic bases. Common amines are the lower alkanol amines, such as monoethanol amine (MEA), isopropanol amine and 2-butanol amine. Also common are the lower alkyl amines. There is a degree of neutralization significantly less than 100% for carboxylic acid surfactants which is optimum for solubilizing the maximum ratio of water to surfactant.

A common nonionic surfactant class useful herein is ethoxylates. These are formed by reacting a mole of alcohol or amine with a number of moles of ethylene oxide (EO). The alcohol or amine generally contains a significant sized hydrocarbon group, for example, an alkylated phenol or a long chain (C<sub>10</sub>-C<sub>20</sub>) alkyl group. Alcohols frequently used are nonyl phenol and lauryl alcohol. The hydrocarbon group serves as the nonpolar section of the molecule. The alcohol can be a can have more than one -OH group and the amine more than one -H, so several ethoxy chains can be present on one molecule. However these multichain ethoxy compounds don't usually function well as surfactants because they do not easily orient at the interface and pack poorly. The balance between hydrophobicity and hydrophylicity is obtained by choosing the hydrocarbon group

and the average number of ethylene oxides added. Commonly 3-5 moles of EO are added per mole alcohol or amine.

Another common class of nonionic surfactants useful herein is long chain (C<sub>10</sub>-C<sub>20</sub>) alcohols. These are frequently derived from hydrogenation of fatty acids, e.g., myristyl alcohol from myristic acid. Another source is ethylene oligomerization.

Microemulsions may include a “cosurfactant” (e.g., n-pentanol), which is not in itself a surfactant (i.e., a material that can not be used as the sole surfactant, but which may be included to improve the functioning of the material which per se can be used herein as a surfactant). Use of co-solvents is theorized to lower the interfacial tension and reduce dramatically the surfactant requirement. Other co-solvents included n-butanol, n-hexanol, 2 methyl 1-pentanol, 2 methyl 1-hexanol and 2 ethyl 1-hexanol.

One skilled in the art would readily be able to select the amount and type of surfactant to form the desired water clusters, while taking account other considerations (e.g., skin irritation potential) which may be associated with a particular surfactant(s).

The water cluster/surfactant(s) will be present in the oil as a water-in-oil (W/O) emulsion. The W/O emulsions will be comprise of the water clusters (individual or arrays thereof in the forms, shapes and dimensions described above) with surfactants molecules attached thereto. As shown in Figures 2 & 3, the single dodecahedral water cluster with fatty-acid surfactant would exist as a W/O emulsion in the cosmetic oil. The water cluster itself is spherical and has a diameter of about 0.8 nanometer (8 Angstroms), with the surfactant molecule extending from the cluster, resulting in a W/O reverse micelle of about 3 nanometers (30 Angstroms) in diameter. As shown in Figures 7 & 8, a five - dodecahedral water cluster needle-like array with fatty-acid surfactant would also

exist as a W/O emulsion in the cosmetic oil. The water cluster array itself is needle-like and has one dimension of about 0.8 nanometer an a length of about 3 nanometers, with the surfactant molecule linearly clathrated in the needle cavity, resulting in a cylindrically symmetric W/O micelle of about 4 nanometers.

5 (40 Angstroms) in its largest dimension and about 0.8 nanometers (8 Angstroms) in its smallest dimension

Preferred concentrations of water by weight are about 5-50% with the surfactant concentration (typically one surfactant molecule per water cluster) 10 chosen to maximize the presence of water clusters between about 0.5 and 10 nanometers (about 5-100A), and preferably water clusters about 0.8nm (about 8A) size in the formulation, to minimize separation of water and oil phases prior to application, thereby ensuring long shelf life.

## 15 APPLICATION OF WATER NANOCLUSTERS TO THE SKIN

The present invention provides a process for delivery of water 20 nanoclusters through the outmost layer of skin. First, a water nanocluster composition comprising water nanoclusters having diameters between 0.5 and ten nanometers (5-100A) and preferably water clusters of diameter less than one nanometer (10A) and an oil formulation is prepared. The water nanocluster composition is then applied preferably to the outermost layer of human skin.

The skin as a physiological regulator plays a key role in the general 25 metabolism of water in the body. Thus the moisture level of the outermost layer of the skin, the stratum corneum, is critical to maintaining the skin surface healthy and supple. Yet the stratum corneum is believed to be mainly responsible for the rate limiting of skin moisture permeation through the hydrophobic barrier presented by its intercellular lipids (H.Schaefer et al., in Novel Cosmetic Delivery 30 Systems, S. Magdassi and E. Touitou, Eds., Marcel Dekker, New York, 1999, pp. 9-49).

First-principles quantum-chemistry computations of the electronic structure and low-frequency vibrational modes of water nanoclusters discussed herein, suggest that the permeating clusters will (1) clathrate and deactivate lipid hydrophobes responsible for the stratum corneum hydration barrier, (2) chemically scavenge free radicals that otherwise damage and age epidermal cells, (3) enhance the transdermal delivery of ingredients and (4) be subject to less water evaporation on the skin surface because of the intrinsic stability of the water nanoclusters.

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The present invention provides a process and formulation which is capable of providing an effective (1) skin moisturizer, (2) anti-oxidant capable of reducing cell damage and ageing and (3) a mechanism for the delivery of beneficial cosmetic and/or pharmaceutical ingredients to the skin.

15

The skin moisturizer benefits are provided due to the present invention's unique capability of effectively overcoming the skin hydration barrier. First, the preferred water clusters of these this invention are less than the 10A (1nm) size characteristic of the hydrophobic lipid intermolecular spacing and pore diameter of human skin, which enables physical penetration. Second, these water clusters have the unique capability of enclosing or "clathrating" lipid hydrophobes, which thereby counteract the hydrophobic effects of the lipid hydrophobes. This is exemplified in Figure 3 for a pentagonal dodecahedral water cluster clathrating the end of a typical fatty acid lipid.

25

The antioxidant benefits include chemically scavenging free radicals that otherwise damage and age epidermal cells. These benefits are obtained from the functionality of these water clusters after the formulation containing them has been applied to the skin and effectively penetrate the to the outermost layer of human skin. After such penetration has occurred, these water clusters further serve as active antioxidants for scavenging cell-damaging free radicals.

Providing anti-oxidants, such as Vitamin E, to the human body by ingestion and dermal penetration has been a matter of considerable technical and commercial focus. Vitamin E antioxidant function is believed to be associated with its ability to donate electrons to cell-destroying free radicals via the  $p\pi$  molecular electron

5 orbitals located on the carbon ring moiety at one end of the molecule, as shown in Fig. 6. Without being limited to the theoretical explanation thereof, it is believed that the antioxidant functionality of the water cluster formulations of this invention is generally similar to that of Vitamin E but is based upon the electron-donating power of the unique water-cluster surface  $p\pi$  molecular electron orbitals, coupled 10 with the low-frequency water-cluster breathing vibrational modes through the dynamic Jahn-Teller effect. As shown in Figures 5 & 9, the unique water-cluster surface  $p\pi$  electron-donating molecular orbitals are qualitatively similar to the  $p\pi$  molecular electron orbitals located on the carbon ring moiety at one end of the Vitamin E molecule shown in Fig. 6.

15 Individual pentagonal or needle-like arrays of pentagonal dodecahedral clusters like the ones shown in Figs. 2 & 7 holding an extra electron donated by the surfactant (Figs. 3 & 10) are potentially powerful antioxidants equal to or better than Vitamin E because of the effectively large reactive cross sections of 20 the cluster surface delocalized oxygen  $p\pi$  orbitals mapped in Figs 5 & 9. As shown in Figures 5 & 9, these water clusters can function as electron reservoirs for chemical reactions involving electron transfer to the reacting species. Thus water-cluster hydrated-electron delocalized orbitals, originating on the cluster surface oxygen atoms, can readily overlap with and scavenge cell-damaging free 25 radicals.

Small polyhedral clusters of water molecules, especially quasiplanar and concatenated pentagonal water clusters (e.g. Figs. 1 & 2), have been experimentally identified as being key to the hydration and stabilization of 30 biomolecules (M.M. Teeter, Proc. Natl. Acad. Sci. 81, 6014. 1984), proteins (T. Baker et al., in Crystallography in Molecular Biology, D. Moras et al., Eds.,

Plenum, New York, 1985, pp 179-192), DNA (L.A. Lipscomb et al., Biochemistry 33, 3649, 1994), and DNA-drug complexes (S. Neidle, Nature 288, 129, 1980).

Such examples indicate the tendency of water pentagons to form closed geometrical structures like the pentagonal dodecahedra shown in Figs. 1 and 2.

5 It has also been suggested that such water clusters may play a fundamental role in determining biological cell architecture (J. G. Watterson, Molec. And Cell. Biochem. 79, 101, 1988). Approximately 70 percent of the human body is water by weight. Much of that water is believed not to be ordinary bulk liquid, but instead, nanoclustered, restructured water which affects biomolecular processes  
10 ranging from protein stability to enzyme activity (J.L. Finney, Water and Aqueous Solutions, G.W. Nelson and J.E. Enderby. Eds., Adam Hilger, Bristol, 1986, pp. 227-244).

## EXAMPLES

### 15 EXAMPLE 1

A Water Nanocluster /Cosmetic Oil formulation is prepared by mixing the following ingredients to make 1 Kg of formulation.

	<u>Component</u>	<u>Weight Percent</u>
20	Soybean Oil	50
	Water	25
	Surfactant	20
	Surfactant II	4
	Surfactant III	1

25 The water is deionized. Surfactant I is an ethoxylate with the molecular structure  $C_8H_{17}(OCH_2CH_2)_6OH$ . Surfactant II is a polyglyceryl-oleate. Surfactant III (a cosurfactant) is n-pentanol.

30 The nanoemulsions are prepared by mixing the soybean oil with Surfactants I and II. Water and Surfactant III are then added simultaneously.

The resultant Water Nanocluster /Cosmetic Oil formulations is a W/O emulsion, with a significant population of stable water nanoclusters in the

preferred size range deliverable to the skin are prepared. The water nanoclusters are in the <2-10nm nanocluster range as determined by dynamic light scattering and Raman spectroscopy to identify water clusters below 2 nm through their well defined vibrational spectra.

5

The resultant formulation is applied to the skin, as in any conventional cosmetic application, and penetrates the outmost layer of the skin.

## 10 EXAMPLE 2

A second formulation is made as follows:

	<u>Component</u>	<u>Weight Percent</u>
15	Soybean Oil	50
	Water	25
	Surfactant I	12
	Surfactant II	12
20	Surfactant III	1

The water is deionized. Surfactant I is an ethoxylate with the molecular structure  $C_8H_{17}(OCH_2CH_2)_6OH$ . Surfactant II is a partially (50-80%) neutralized (with isopropanol amine) soybean fatty acid. Surfactant III (a cosurfactant) is n-pentanol.

25 The nanoemulsions are prepared by mixing the soybean oil with Surfactants I and II. Water and Surfactant III are then added simultaneously.

## 30 EXAMPLE 3

35 Another cosmetic formulation is formed from the following ingredients:

	<u>Component</u>	<u>Weight Percent</u>
35	Soybean Oil	50
	Water	25
	Surfactant I	20
	Surfactant II	4
	Surfactant III	1

The water is deionized. Surfactant I is a partially (80%) neutralized (with isopropanol amine) soybean fatty acid. Surfactant II is an ethoxylate with the molecular structure C<sub>8</sub>H<sub>17</sub>(OCH<sub>2</sub>CH<sub>2</sub>)<sub>m</sub>OH. Surfactant III (a cosurfactant) is n-pentanol.

- 5 The nanoemulsions are prepared by mixing the soybean oil with Surfactants I and II. Water and Surfactant III are then added simultaneously.

#### EXAMPLE 4

- A cosmetic oil in which the water is not in the form of nanosized micelles is 10 made as follows:

	<u>Component</u>	<u>Weight Percent</u>
	Soybean Oil	73
	Water	25
15	Surfactant I	1
	Surfactant II	3

The water is deionized. Surfactant I is a polyglyceryl-oleate. Surfactant II (a cosurfactant) is n-pentanol. The nanoemulsion is prepared by mixing the soybean oil with Surfactant I. Water and Surfactant II are then added 20 simultaneously.

Three grams of this formulation are placed on a watch glass and this watch glass is placed on a scale. Three grams of the formulation of Example 1 are placed on another watch glass on another scale. Weight losses for each are 25 as follows:

		<u>Weight loss, mg.</u>	
	<u>Time, hr.</u>	<u>Example 1</u>	<u>Example 4</u>
	1	28	122
	2	62	226
30	3	83	307

#### EXAMPLE 5

The cosmetic mixtures of Examples 1 and 4 are made up as above. Five (5) grams of each is placed on two 5 cm x 5 cm samples of synthetic skin manufactured by Integra Life Sciences Company, under the trade name Integra, which has a water permeability comparable to that of human skin. Five layers of 5 filter paper are placed under each skin sample. Periodically the filter paper samples are weighed. The percent transport of the water through each skin layer is as follows:

	<u>Time hr.</u>	<u>Example 1</u>	<u>Example 4</u>
10	2	7	2
	5	22	8
	10	41	14

#### **EXAMPLE 6**

A transdermal Water Nanocluster/Vitamin C/Oil antioxidant formulation is prepared by mixing the following ingredients to make 1 Kg of formulation.

	<u>Component</u>	<u>Weight Percent</u>
20	Light mineral oil	40
	Water	25
	Vitamin C	10
	Surfactant	20
	Surfactant II	4
	Surfactant III	1

25 The water is deionized. Surfactant I is an ethoxylate with the molecular structure C<sub>8</sub>H<sub>17</sub>(OCH<sub>2</sub>CH<sub>2</sub>)<sub>6</sub>OH. Surfactant II is a polyglyceryl-oleate. Surfactant III (a cosurfactant) is n-pentanol.

30 The nanoemulsions are prepared by mixing the mineral oil with Surfactants I and II. Water, Vitamin C, and Surfactant III are then added simultaneously.

The resultant Water Nanocluster/Vitamin C/Oil formulation is a W/O nanoemulsion, with a significant population of stable water nanoclusters clathrating the Vitamin C in the preferred size range deliverable to the skin are prepared. The water nanoclusters are in the <2-10nm nanocluster range, as 5 determined by dynamic light scattering and Raman spectroscopy to identify water clusters below 2 nm through their well defined vibrational spectra.

The resultant formulation is applied in small amounts to the skin and penetrates the outmost layer of the skin.

10

## EXAMPLE 7

A transdermal Water Nanocluster /Oil/ Vitamin E antioxidant formulation is prepared by mixing the following ingredients to make 1 Kg of formulation.

	<u>Component</u>	<u>Weight Percent</u>
15	Light mineral oil	40
	Water	25
	Vitamin E	10
20	Surfactant	20
	Surfactant II	4
25	Surfactant III	1

The water is deionized. Surfactant I is an ethoxylate with the molecular structure  $C_8H_{17}(OCH_2CH_2)_6OH$ . Surfactant II is a polyglyceryl-oleate. Surfactant III (a cosurfactant) is n-pentanol.

The nanoemulsions are prepared by mixing the mineral oil with Surfactants I and II and Vitamin E. Water and Surfactant III are then added simultaneously.

30

The resultant Water Nanocluster/Oil/Vitamin E formulation is a W/O nanoemulsion, with a significant population of stable water nanoclusters in the preferred size range deliverable to the skin are prepared. The water nanoclusters are in the <2-10nm nanocluster range, as determined by dynamic light scattering

and Raman spectroscopy to identify water clusters below 2 nm through their well defined vibrational spectra.

The resultant formulation is applied in small amounts to the skin and penetrates the outmost layer of the skin.

5

## EXAMPLE 8

A transdermal water Nanocluster /Nano Zinc Oxide/Oil antibacterial formulation is prepared by mixing the following ingredients to make 1 Kg of

10 formulation.

<u>Component</u>	<u>Weight Percent</u>
Light mineral oil	40
Water	25
Nano Zinc Oxide	10
Surfactant	20
Surfactant II	4
Surfactant III	1

The water should be deionized. Surfactant I is an ethoxylate with the molecular

15 structure  $C_8H_{17}(OCH_2CH_2)_6OH$ . Surfactant II is a polyglyceryl-oleate. Surfactant III (a cosurfactant) is n-pentanol.

**WHAT IS CLAIMED IS:**

**CLAIMS**

- 5 1. A process for delivery of water nanocluster compositions through the  
outmost layer of human skin, comprising the steps of:  
preparing a water nanocluster water-in-oil (W/O) emulsion composition  
comprising water nanoclusters having with at least one dimension thereof being  
less than about ten (10) nanometers and an oil formulation in the form of a W/O  
10 emulsion, and  
applying said water nanocluster composition into the outermost layer of  
human skin.
- 15 2. The process of Claim 1 wherein said water nanocluster composition  
further comprises one or more surfactants selected from the group consisting of  
fatty acids, ethoxylates and alcohols.
- 20 3. The process of Claim 2 wherein said surfactants comprises about 5 to  
25% by weight of said water nanocluster composition.
4. The process of Claim 1 wherein said water clusters are predominantly in  
concatenated pentagonal form.
- 25 5. The process of Claim 1 wherein said water clusters are predominantly in  
the form of dodecahedrals.
6. The process of Claim 1 wherein said water nanocluster composition is  
comprised of 10-50% by weight water.
- 30 7. The process of Claim 1 wherein said oil formulation is a cosmetic oil.

8. The process of Claim 7 wherein said water nanocluster composition is comprised of:

- (1) about 5 to 50% by weight water,
- (2) about 10 to 90% by weight of a cosmetic oil formulation and
- 5 (3) about 5 to 50% by weight of one or more surfactants selected from the group consisting of fatty acids, ethoxylates and alcohols.

9. The process of Claim 1 wherein said water nanoclusters in said water nanocluster composition are present together with bulk water but constitute the 10 predominate form of water present in said water nanocluster composition.

10. The process of Claim 1 wherein said oil formulation includes pharmaceutical ingredients.

15 11. A water-in-oil (W/O) emulsion composition comprised of:

- (1) about 5 to 50% by weight water containing water clusters having at least one dimension of less than about 10 nanometer,
- (2) about 10 to 90% % by weight of an oil formulation and
- (3) about 5 to 50% % by weight of one or more surfactants selected

20 from the group consisting of fatty acids, ethoxylates and alcohols. The composition of Claim 11 wherein said at least one dimension is less than about 1 nanometer.

25 12. The composition of Claim 11 wherein said water clusters are predominantly in concatenated pentagonal water cluster form.

13. The composition of Claim 13 wherein said concatenated pentagonal water clusters are in the form of pentagonal dodecahedrals having protruding delocalized  $p\pi$  orbitals.

14. The composition of Claim 11 wherein said concatenated pentagonal water clusters are comprised of twenty-one or fewer water molecules and having a diameter of less than about 0.8 nanometers in diameter

5 15. The composition of Claim 11 wherein said water clusters are in multi-water cluster arrays.

10 16. The composition of Claim 11 wherein said multi-water cluster arrays are need-like in form, having at least one dimension less than about 1 nanometer and a second dimension greater than about 3 nanometers

17. The composition of Claim 11 wherein the composition is in the form of a water-in-oil nanoemulsion.

15 18. The composition of Claim 18 wherein said water/oil nanoemulsion is comprised of micelles containing the water clusters and surfactants, and said micelles have an average diameter of about 5 nanometers.

20 19. The composition of Claim 11 wherein the composition is in the form of a gel.

20. The composition of Claim 11 wherein the composition is in the form of a cream.

25 21. The composition of Claim 11 wherein the composition is in the form of a liquid.

30 22. The composition of Claim 11 wherein the oil formulation is a cosmeticoil selected from the group consisting of soybean, peanut, olive sesame and paraffin.

23. The composition of Claim 23 said oil formulation includes one or more additives selected from the group consisting of nutrients, fragrances and sunscreens, which are soluble in the cosmetic oil formulation.

5 24. The composition of Claim 11 wherein said oil formulation includes pharmaceutical ingredients.

## ABSTRACT OF THE DISCLOSURE

The present invention provides a process for delivery of water nanoclusters of diameter less than about one nanometer to the skin to yield high epidermal permeability and improved delivery of water to within the outer layer of human skin. This invention provides effective water-cluster-based formulations for a broad range of water/oil nanoemulsion configurations.

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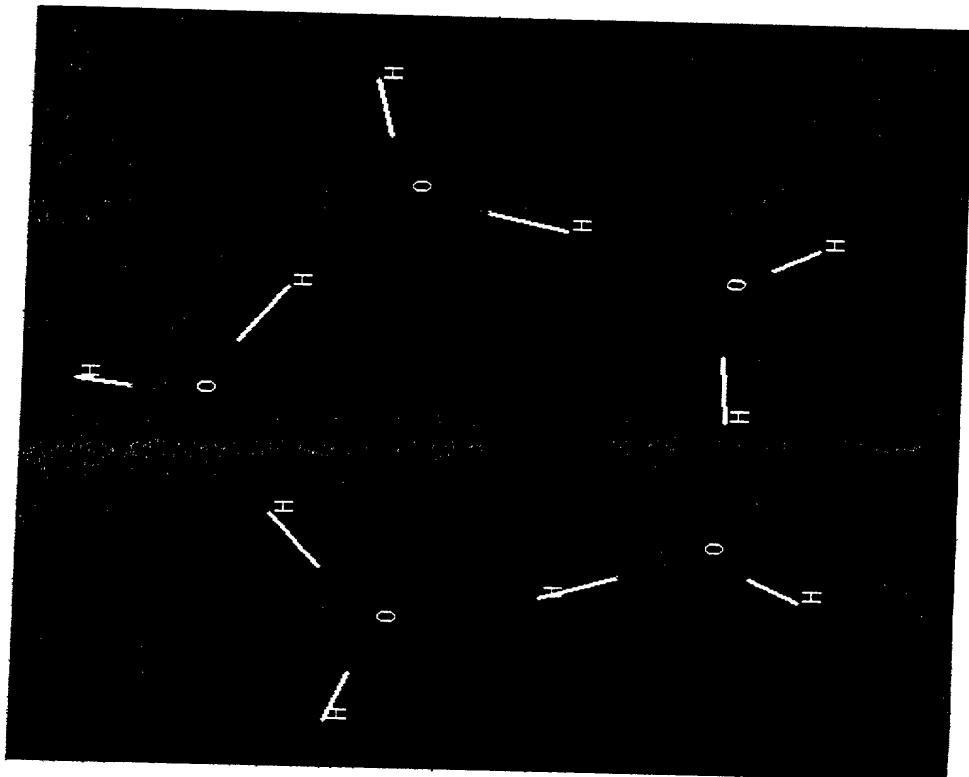


FIG. 1

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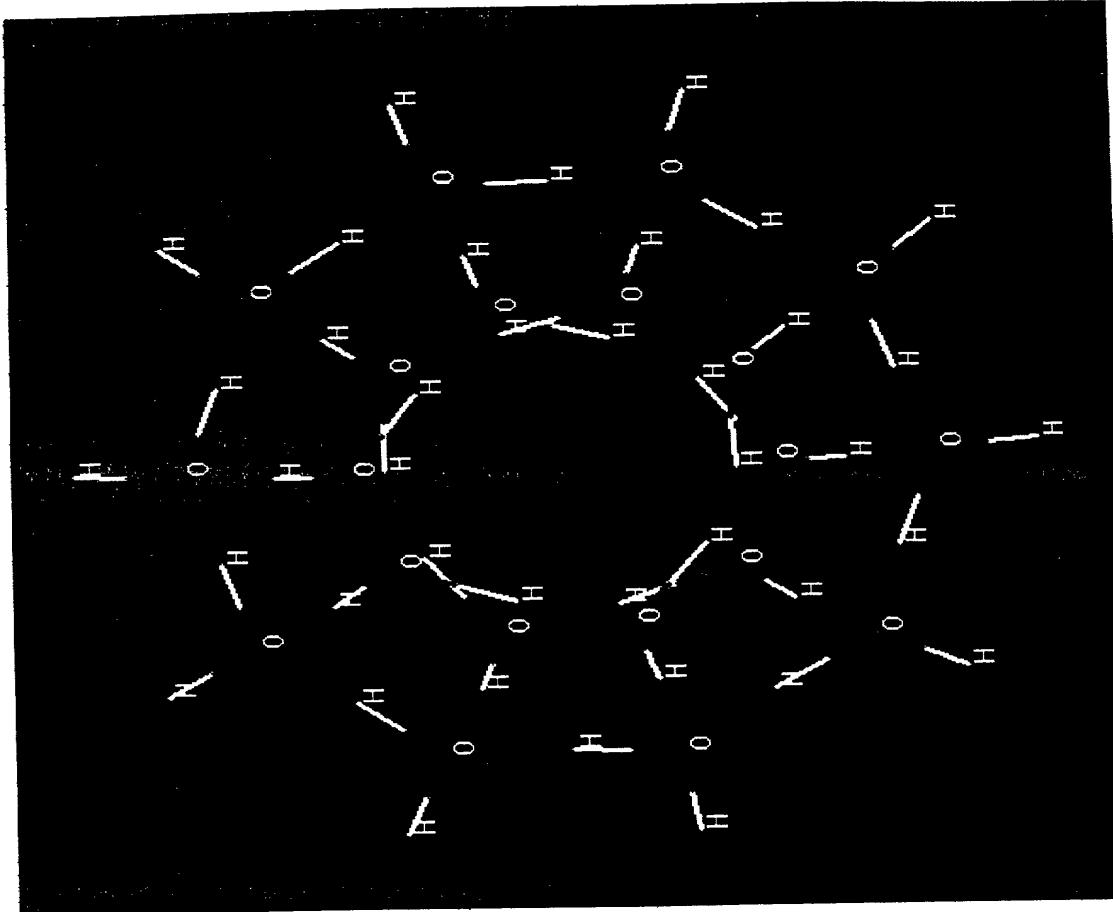
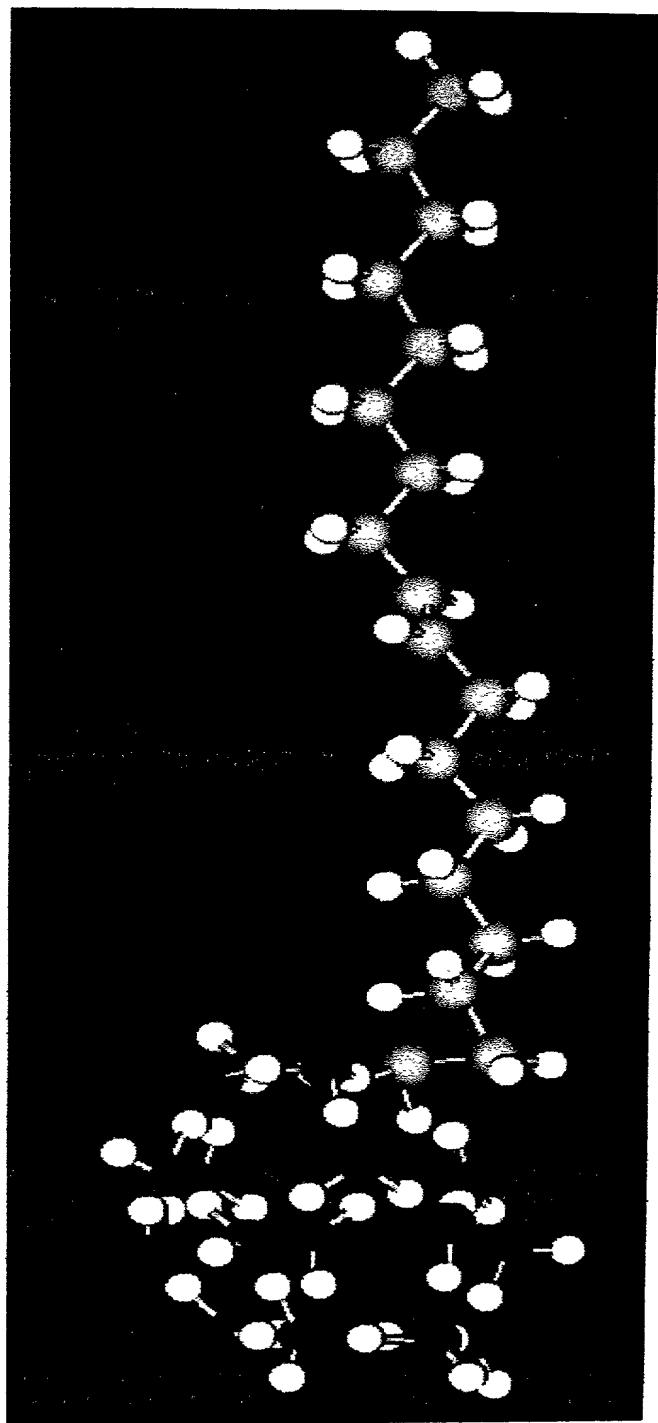


FIG. 2

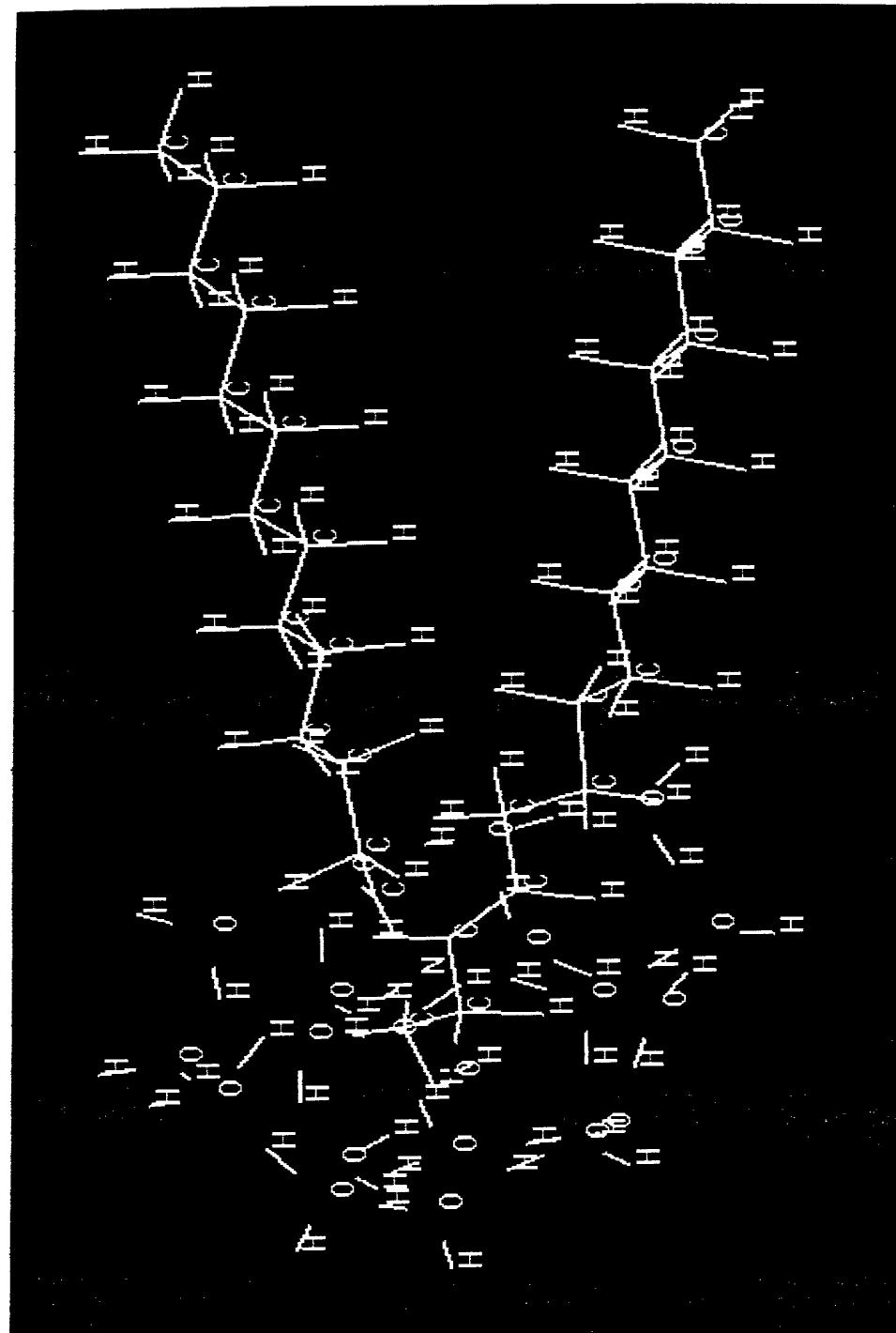
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FIG. 3



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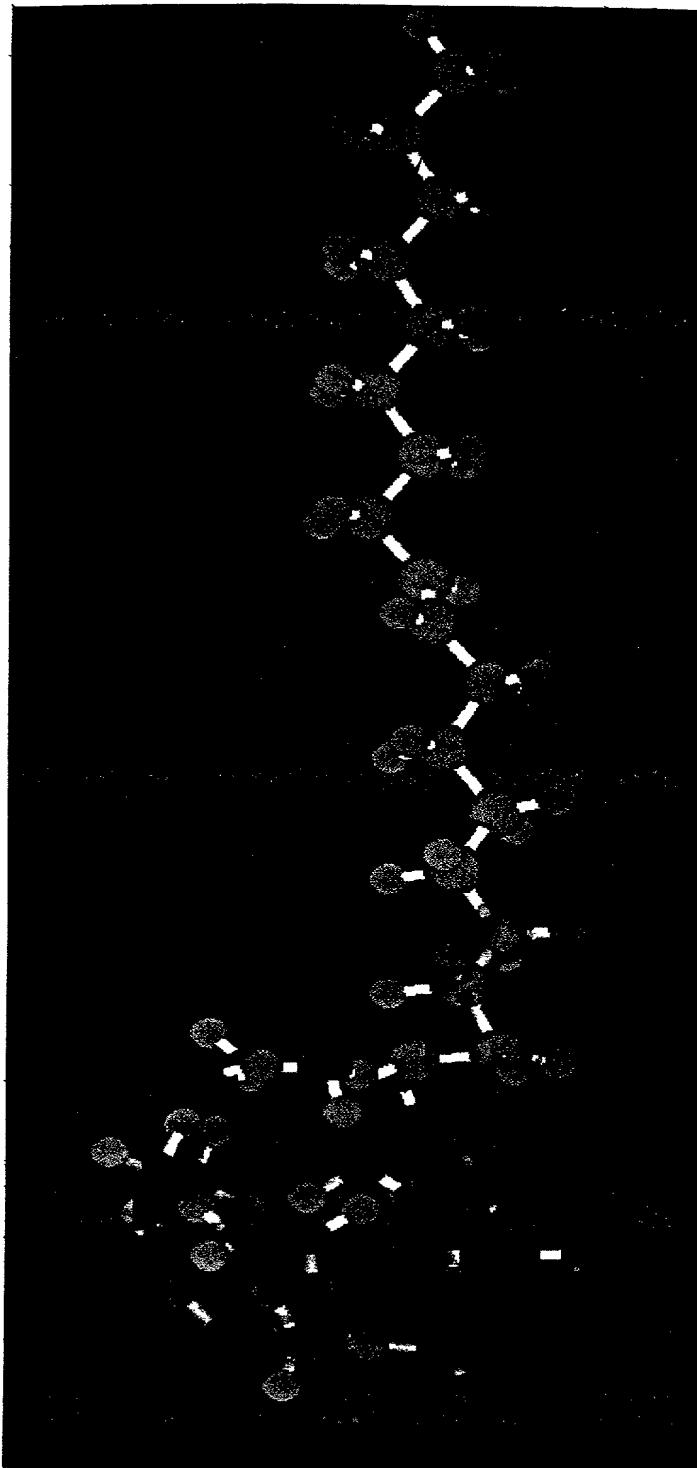
FIG. 4



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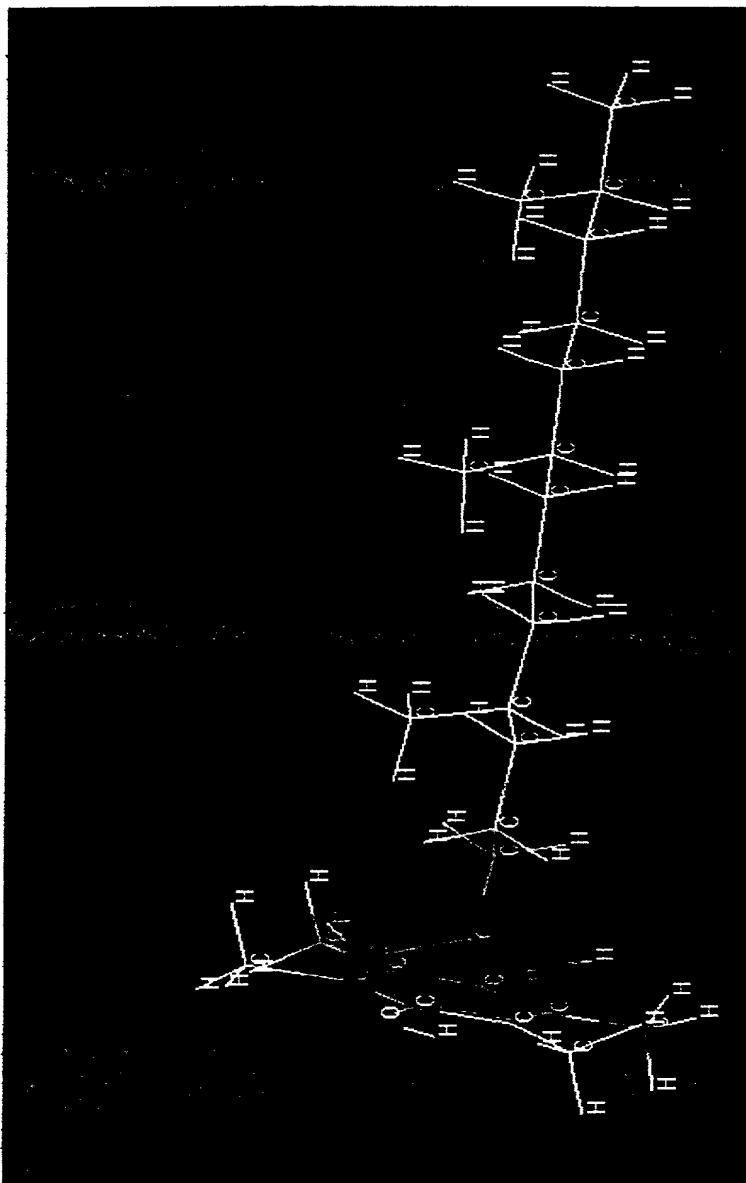
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FIG. 5



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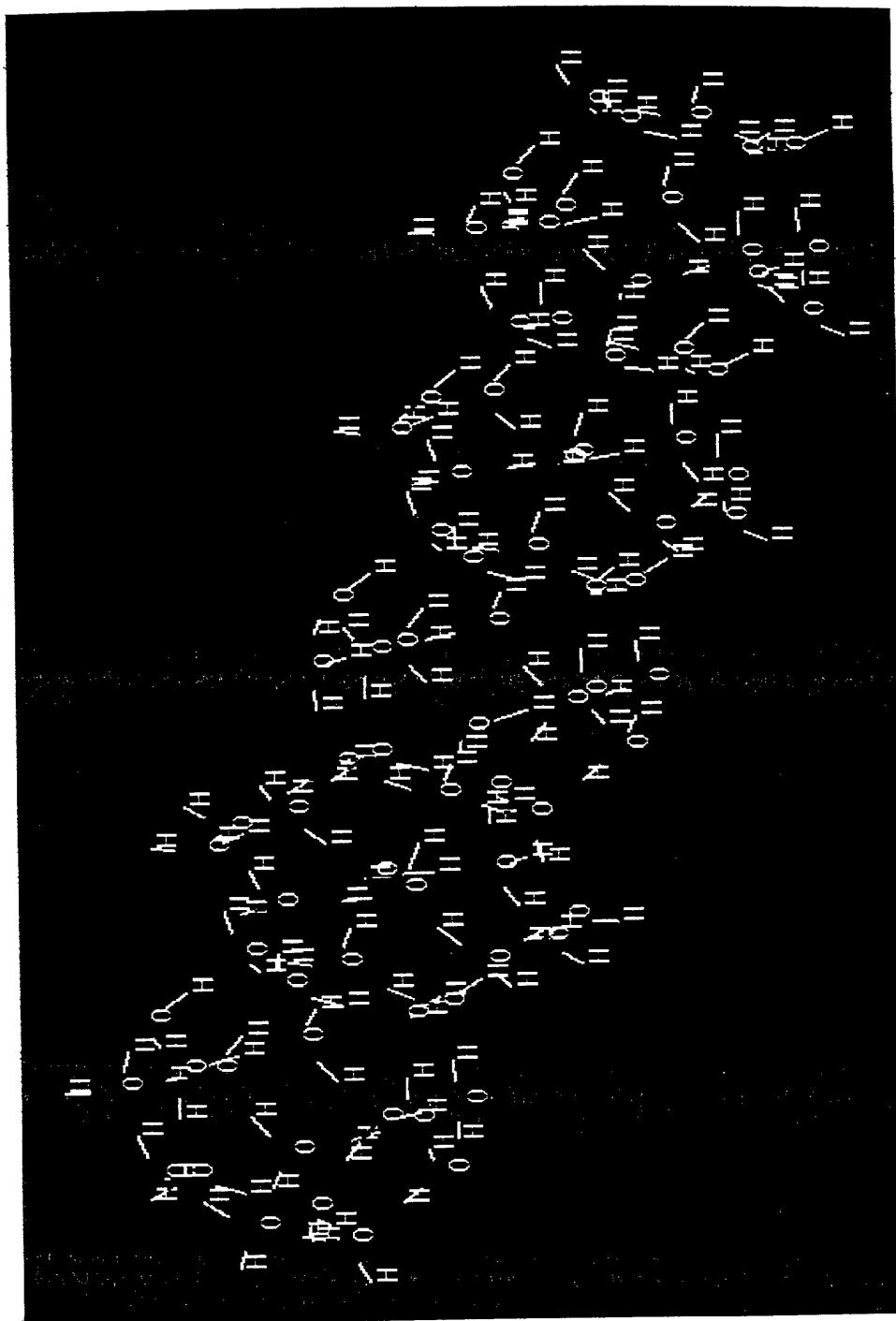
FIG. 6



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FIG. 7



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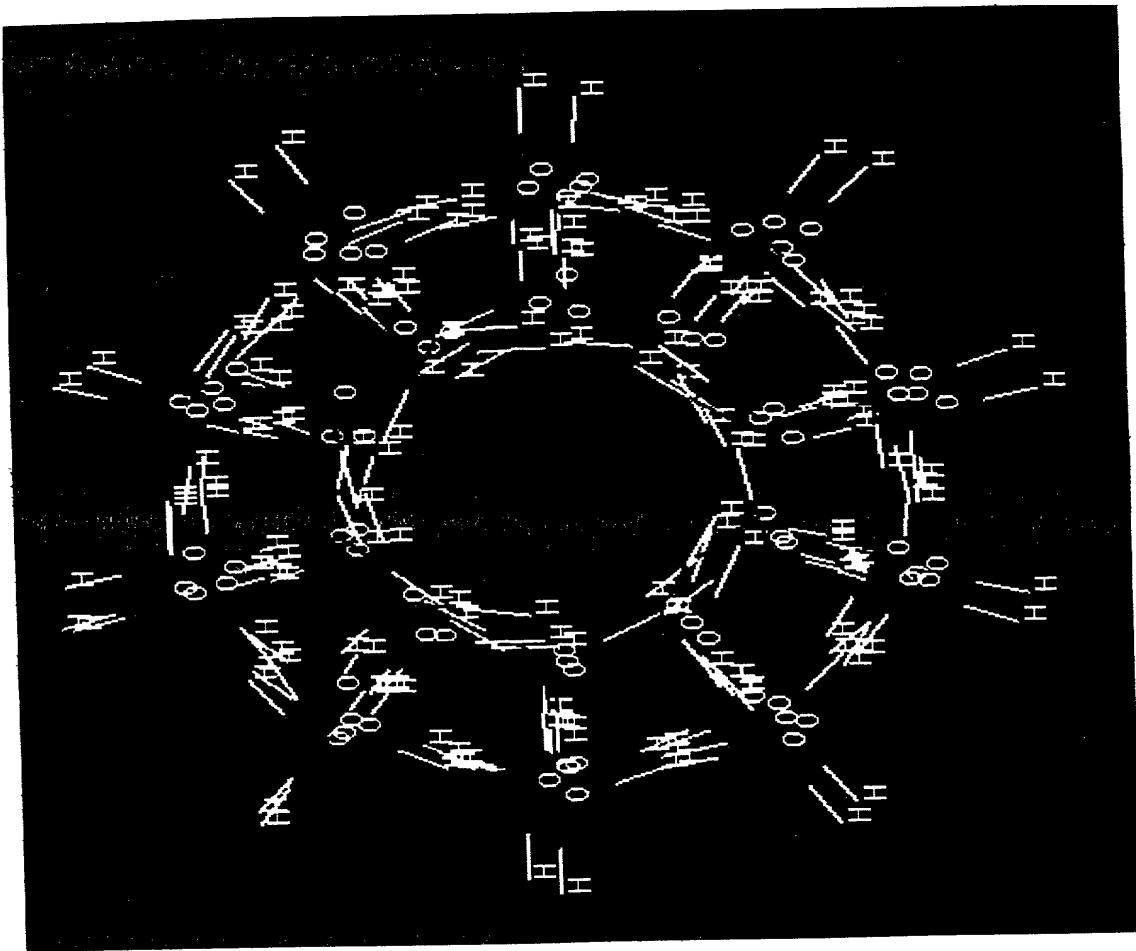


FIG. 8

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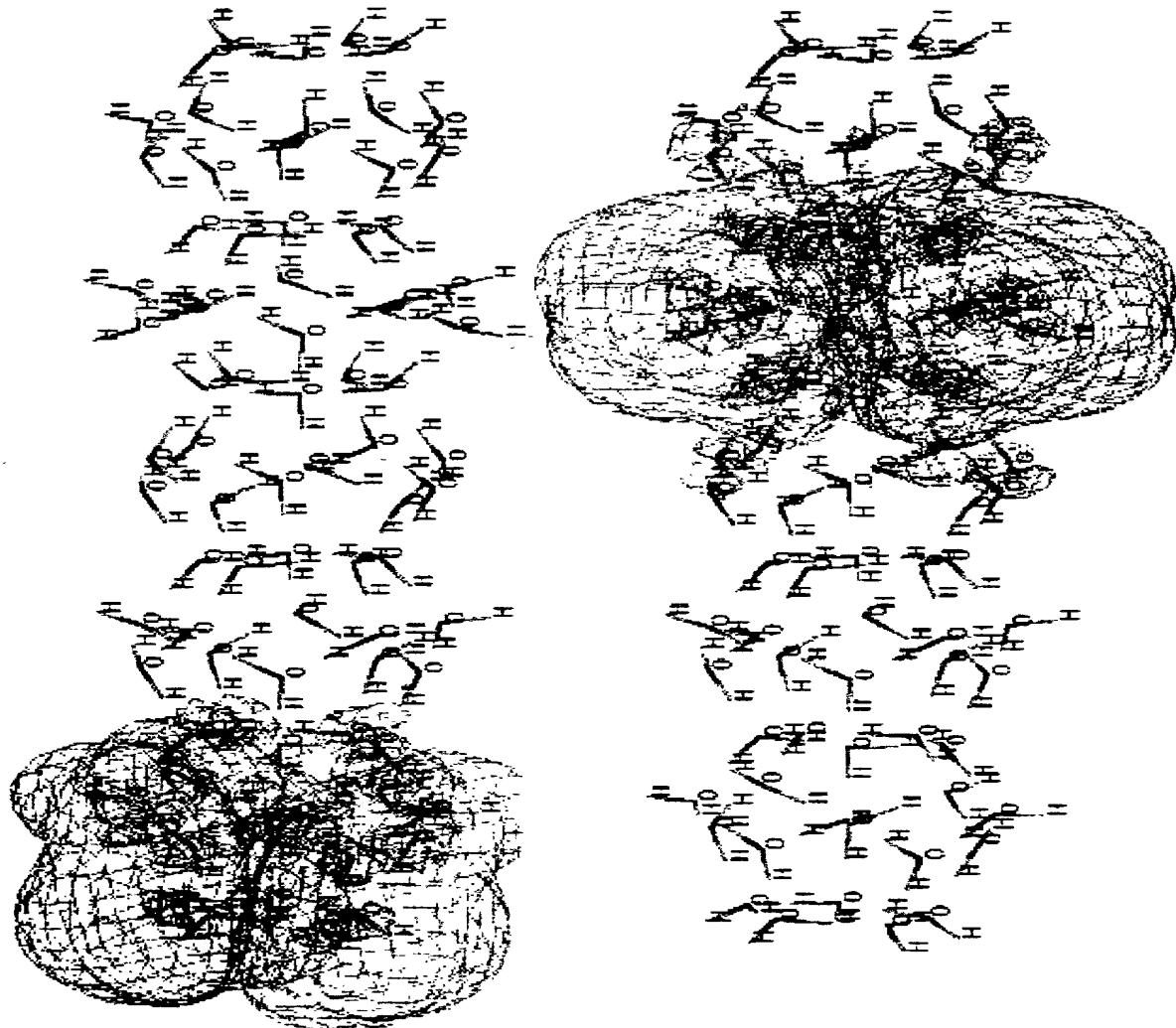


FIG. 9

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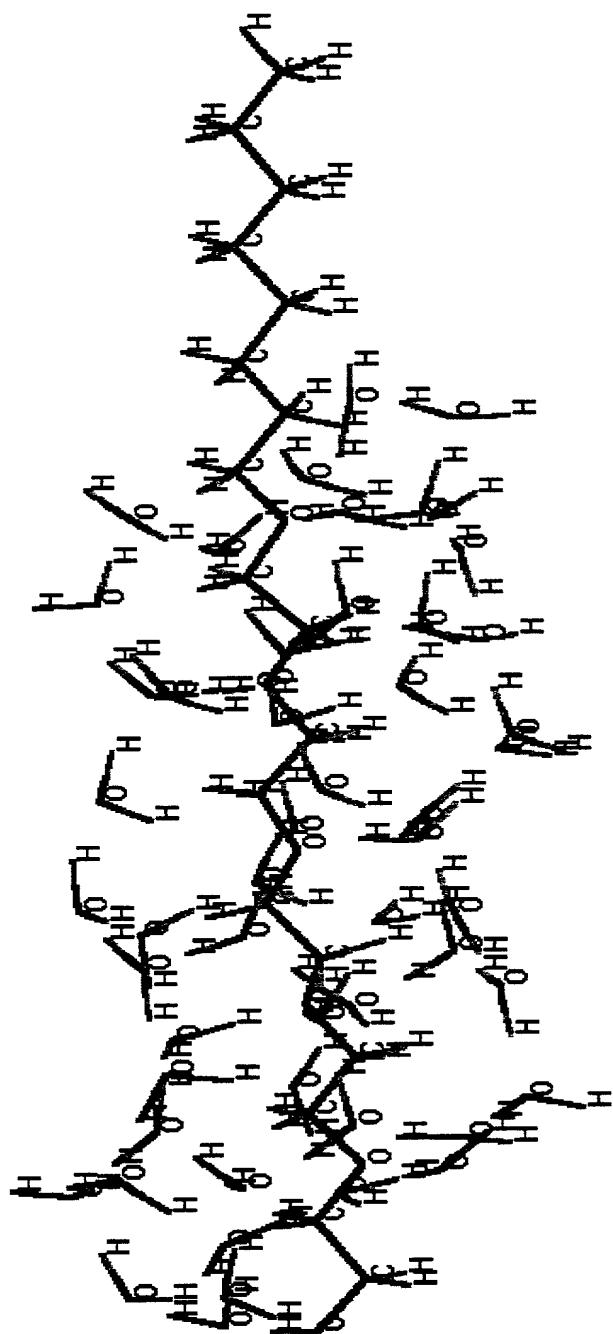


FIG. 10

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Johnson, et al.

Serial No.:

Filed:

For: APPLICATION OF WATER NANOCLUSTERS TO SKIN

Commissioner for Patents

Washington, DC 20231

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS37 CFR 1.9(f) and 1.27(c)  
SMALL BUSINESS CONCERN

I hereby declare that I am

- the owner of the small business concern identified below:  
 an official empowered to act on behalf of the small business concern identified below:

NAME OF CONCERN: Quantum Energy Technologies CorporationADDRESS OF CONCERN: 238 Main Street, Suite 201  
Cambridge, MA 02142

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For the purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full time, part time, or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when, either directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract of law have been conveyed to and remain with the small business concern identified above with regard to the invention titled:

TITLE: APPLICATION OF WATER NANOCLUSTERS TO SKIN

by:

INVENTOR(S): Keith H. Johnson

described in:

- the specification filed herewith  
 U.S. Patent Application Serial Number \_\_\_\_\_ filed \_\_\_\_\_.  
 U.S. Patent Number \_\_\_\_\_ issued

If the rights of the above-identified small business concern are not exclusive, each individual, concern, or organization having rights to the invention is listed below\* and no rights to the invention are held by any person, other than the inventor(s), who could not qualify as a small business concern under 37 CFR 1.9(d) or a non-profit organization under 37 CFR 1.9(e).

\*NOTE: Separate verified statements are required from each named person, concern, or organization having rights to the invention, averring to their status as small entities. (37 CFR 1.27).

FULL NAME: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

INDIVIDUAL  SMALL BUSINESS CONCERN  NON-PROFIT ORGANIZATION

FULL NAME: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

INDIVIDUAL  SMALL BUSINESS CONCERN  NON-PROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING: Eugene Berman

TITLE IN ORGANIZATION: Vice President

ADDRESS OF PERSON SIGNING 10-K Gill Street, Woburn, MA 01801

SIGNATURE:  DATE: 8/29/00

**DECLARATION BY THE INVENTOR**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**APPLICATION OF WATER NANOCLOUDS TO SKIN**

the specification of which (I authorize Choate, Hall & Stewart to check one of the following, three choices, and fill in the blanks, if applicable):

X is attached hereto

\_\_\_\_\_ was filed on \_\_\_\_\_ as Application Serial No. \_\_\_\_\_ and amended on \_\_\_\_\_ (if applicable).

\_\_\_\_\_ was filed as PCT international application No. \_\_\_\_\_, on \_\_\_\_\_ and was amended under PCT Article 19 on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understood the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s): Priority Claimed

(Number)	(Country)	(Day/Month/Year/Filed)	Yes	No
_____	_____	_____	_____	_____

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.) (filing date) (status-patented, pending, abandoned)

(Application Serial No.) (filing date) (status-patented, pending, abandoned)

PCT Applications designating the United States:

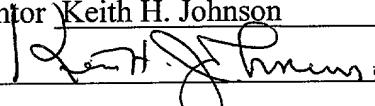
(PCT Appl. No.) (U.S.S.N.) (status-patented, pending, abandoned)

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national filing date of this application.

Provisional Application(s):

Application Number Filing Date Status

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United State Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

Full name of first inventor Keith H. Johnson  
Inventor's signature:  Date: 8/28/00

Residence: 239 Mount Auburn Street, Cambridge, MA 02138

Citizenship: U.S.A.

Post Office Address: same

ATTORNEY'S DOCKET NO.: 2000200-0003

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Johnson, et al.

Serial No.:

Filed:

For: APPLICATION OF WATER NANoclUSTERS TO SKINS

Commissioner for Patents  
Washington, D.C. 20231

Sir:

APPOINTMENT OF ATTORNEY

The undersigned hereby appoints Brenda Herschbach Jarrell, Registration No. 39,223; Sam Pasternack, Registration No. 29,576; Kevin M. Tormey, Registration No. 41,351; Karoline Shair, Registration No. 44,332; Elizabeth Nugent, Registration No. 43,839; Anne-Marie Dinius, Registration No. 45,592; Valarie B. Rosen, Registration No. 45,698; Stanley C. Mah, Registration No. 46,189; C. Hunter Baker, Registration No. P-46,533 and Monica R. Gerber, Registration No. P-46,724 as its attorneys and agents for prosecution of matters relating to the above-identified trademark application and to conduct all business in the United States Patent and Trademark Office.

All correspondence should be sent to Brenda Herschbach Jarrell, Choate, Hall & Stewart, Exchange Place, 53 State Street, Boston, Massachusetts 02109.

Respectfully submitted,

Name: Eugen Bern

Title: VICE PRESIDENT

On behalf of: QUANTUM ENERGY TECHNOLOGIES

Dated: 8/29/00, 2000